$5^d\ 19^h\ 46^m$; the telescope employed a Gregorian reflector of 5 inches aperture, power 100. A drawing of the appearance of this portion, as seen by Captain Ford, accompanied his notice.

On Luminous Rings round Shadows. By the Rev. Baden Powell, Savilian Professor of Geometry, Oxford.

The remarkable optical phenomena attending total solar eclipses, especially the formation of a luminous ring round the disks, are now on the whole so well established, that speculations have been hazarded as to their cause; and though these speculations as yet scarcely amount to more than very general illustrations, yet as experimental facts have been elicited which seem to bear a resemblance to the phenomena in question, they deserve notice, even in the present uncertain state of the inquiry.

The author disclaims any idea of bringing forward such facts as a complete explanation, but he is induced to offer them because *one* experiment devised by him long since was thought by the late Mr. Baily worthy of being laid before the Society, though communicated to him without any such intention. (*Ast. Soc. Notices*, Mar. 10, 1843.)

The following is the author's historical summary of the observations of the luminous ring:—

The phenomenon appears to have been observed as early as the time of Plutarch, as appears by a passage from him cited in the *Comptes Rendus*, 1842, i. 847. In more modern times, probably the earliest recorded instance is in the eclipse of 1567 [This is clearly wrong in date or name], observed by Kepler. The ring was observed at Naples in 1605 (*Phil. Trans.* vol. xl. 177), and from the year 1706 we have the full and well-known records of the most eminent astronomers down to the present day, which establish the phenomenon as a regular part of the appearance of a total eclipse. The author refers to instances in the *Mem. Ast. Soc.* vol. i. 144, and vol. x. 9–16, 37, &c., and to the *Notices* of this Society, vol. v. 207; as also to the *Comptes Rendus* for 1842, parts i. and ii. He remarks that remarkable discrepancies are found in the accounts of the same, as well as of different eclipses, and he mentions instances. Some of these discrepancies admit of easy explanation. In the transit of *Venus* in 1769, light was seen surrounding the part of the planet *off* the sun, both at immersion and emersion; but this has been ascribed to her atmosphere. (*Ast. Soc. Mem.* vol. x. 27.) The singular *protuberances* observed in the eclipses of 1733 and 1842 do not seem to belong to the ring, and it seems to the author hardly conceivable that they can be purely optical phenomena, as suggested by M. Valz and M. Arago.

The author next gives an account of the attempts of different astronomers to assign *a cause* for the luminous ring. Kepler considered it to be due either to combustion round the sun, or to refraction of his rays by the moon's atmosphere. Others have more generally attributed it to some peculiar effect of the solar atmo-

sphere; and some, especially Olbers, expressly attribute it to the zodiacal light. De l'Isle, and, more lately, Arago and Valz, regard it altogether as a phenomenon of diffraction. Several instances are then given of luminous rings surrounding terrestrial objects seen in shadow, as observed by different philosophers.

Experimental imitations of the luminous ring, by artificially eclipsing the sun, were long ago made by De l'Isle and La Hiri (*Mém. Acad. Paris*, 1715, p. 166), and such an intimation is also spoken of by Mr. Baily (*Ast. Soc. Notices*, vol. v. p. 212).

Among the experiments described by Newton in the third book of his *Optics*, one, which is emphatically mentioned as unfinished, seems to bear closely on the present subject. The sun's light being admitted through a hole one quarter of an inch in diameter, and partly intercepted by a knife-edge fixed along one side of a hole three quarters of an inch square in a screen, and falling on a paper beyond, Newton saw "two *streams of faint light* shoot out both ways from the beam of light into the shadow like the tails of comets." Again, placing his eye to receive the light, he saw "*a line of light upon the edge* (of the knife) all along it." "It was contiguous to the edge and narrower than the innermost fringe," and "between the edge and the first fringe." Newton thus clearly distinguishes between this peculiar phenomenon and the ordinary effects of diffraction.

The author then proceeds to detail his experiments made for the purpose of producing the luminous ring, remarking, that the essential conditions in all diffraction experiments are, that the origin of the light be as nearly a point as may be, and that the area of the rays diverging from it extend beyond the edge of the opaque diffracting body.

He finds, that with apertures up to a quarter of an inch, or more, and whether the area of the rays reach beyond the edge of the opaque body, or lie even considerably within it, that a small circular disk, seen at a distance, either with or without a telescope, is edged by a *bright luminous ring*, which cannot be seen with the eye-lens, and is, therefore, *not* an optical image like the diffraction fringes, but is seen in the telescope distinctly, when in focus for the opaque disk. With a straight edge, the same phenomenon is observed as a line of light running along it. If the origin be a lens of short focus, the ring is seen as before, but less perfectly; while the diffraction fringes are seen perfectly with the eye-lens. The origin being a hole, the ring is visible under different variations of the area of the rays, but ceases to be visible when the area is less than about a quarter of the disk. Changes in the distance of the eye from the disk produce very little, if any, change in the breadth of the ring.

The ring was examined by a telescope with cross-wires in its focus. The intersection of the wires was fixed on the edge of the disk before the light was admitted, and on its admission the ring extended sensibly beyond; on its being then fixed on the edge of

the ring, the edge of the disk fell within it on shutting out the light. The experiment was repeated in various ways, to determine the influence of reflexion from the edge, &c. &c.

When the area is a hole, the disk being within the area of the rays, if the shadow of the disk be examined by an eye-lens of two inches' focus, there appear at all points of the circumference streaks of yellowish light radiating into the shadow, and, crossing at the centre, they form there a round, bright spot; but the streaks are supposed to be chiefly due to irregularities in the edge. An analogous phenomenon is seen when a straight edge is used. A modification of the same phenomenon is observed in the case described by the author to the British Association, at the meeting in 1846.

The experiments above were all made by means of the sun's light. There are well-known difficulties in performing any diffraction experiments by candle-light; but the author succeeded in exhibiting the ring by means of the light of a flame placed in the focus of a short lens limited by a circular aperture. When the shadow is thrown on a white screen at about one foot distance from the disk, the middle of the shadow appears faintly illuminated; but no streaks, as in the case of solar light, could be detected, nor is the faint illumination perceptible to the eye viewing the disk directly. The author, in conclusion, makes mention of the theory of M. Babinet, which attempts to explain the phenomenon on the undulatory hypothesis, on this principle, that, " at points exterior to the area of the rays there is no light, owing to the natural destruction of the secondary waves. If, then, of the two rays proceeding to any such point to destroy each other we intercept one by an obstacle, the other remains, and gives rise to a point of light at that point; that is, just beyond the obstacle, a series of luminous points thus created by the removal of interfering rays will give rise to the luminous borders on the edge." (*Nouv. Bulletin des Sciences*, Nov. 1832. Quetelet, *Appendix to Translation of Herschel on Light.*)

The author, in conclusion, remarks that, imperfect as the whole investigation confessedly is, it is by thus making the facts known that we may most reasonably hope to elicit some better elucidation of them.

M. Lerebours, of Paris, forwarded to the Society a notice of several telescopes, with their prices, which he has now to dispose of; the most remarkable of there are, two of $10\frac{1}{2}$ inches aperture, and one of 14 inches aperture. M. Lerebours' catalogue is left with the assistant secretary for inspection.

Erratum in Schumacher's Circular.

Page 153, *for* Mass $=\frac{1}{3900}$ *read* $\frac{1}{9300}$.

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